DRAFT REPORT

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

SECTION 8.0 SUMMARY AND CONCLUSIONS

PREPARED FOR:

NORTHERN DIVISION
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GLOSSARY

ARARs	Applicable or Relevant and Appropriate Requirements
CBU	Construction Battalion Unit
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLP	Contract Laboratory Program
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
CTDEP	Connecticut Department of Environmental Protection
DDTR	DDT and residues
DQO	Data Quality Objective
DRMO	Defense Reutilization and Marketing Office
EIC	Engineer in Charge
EM	Electromagnetic
ESQD	Explosive Safety Quantity Distance
GC	Gas Chromatograph
gpd/ft^2	Gallons per day per square foot
gpm	Gallons per minute
GPR	Ground Penetrating Radar
IAS	Initial Assessment Study
IDL	Instrument Detection Limit
IR	Installation Restoration
MCL	Maximum Contaminant Level
MEK	Methyl Ethyl Ketone
NGVD	National Geodetic Vertical Datum

GLOSSARY

NACIP	Navy Assessments and Control of Installation Pollutants
NEESA	Naval Energy and Environmental Support Activity
NESO	Navy Environmental Support Office
NTUs	Nephelometric Turbidity Units
OBDA	Over Bank Disposal Area
OBDANE	Over Bank Disposal Area Northeast
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PM10	Concentration of suspended particulate matter in air for a particle size fraction of ten microns or less.
POC	Point of Contact
ppb	parts per billion
ppm	parts per million
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
RQD	Rock Quality Designation
SARA	Superfund Amendment and Reauthorization
SCS	Soil Conservation Service
SVOs	Semi-Volatile Organics
TAL	Target Analyte List

GLOSSARY

TIC	Tentatively Identified Compounds
TRC	Technical Review Committee
TBC	"To be considered" values
TCLP	Toxicity Characteristic Leachate Procedure
TPH	Total Petroleum Hydrocarbons
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOAs	Volatile Organic Compounds

8.0 SUMMARY AND RECOMMENDATIONS

This section discusses the summary and conclusions of the investigations and evaluations at each site. Included are overviews of site background, nature and extent of contamination, and health and ecological risk assessment. Based on this information, for Step I sites, a recommendation is provided for proceeding to Step II, or for no further action. A no further action recommendation is based on identification of no significant contamination, exceedances of ARARs, and no health and ecological risk. Recommendations to proceed from Step I to Step II are based on identification of contaminants above applicable ARAR/TBC values, and where health and ecological risks are of concern. In some cases, recommendations to proceed from Step I to II are based on the need for further delineation of the extent of contamination (e.g., Battery Acid Disposal Area), or to define the source of contaminants (e.g., Torpedo Shops).

Step II sites will now proceed to the Feasibility Study (FS). The Feasibility Study is a detailed evaluation of remedial (clean-up) alternatives at each Step II site, including no action.

The following discussion of summary and recommendations is provided for each site.

8.1 Step I Sites

8.1.1 CBU Drum Storage Area 5A

8.1.1.1 Summary

Background: The CBU Drum Storage Area is located in the northern section of NSB-NLON, adjacent to the deployed parking lot, and within the Area A Landfill. Twenty-six 55 gallon drums of waste oil, lube oil, and paint materials were previously located at this site.

Nature and Extent of Contamination: Seven (7) surface soil samples were collected from three sample locations to screen for potential contamination. Low concentrations of VOCs and SVOs were detected in the surface soils at this site. However, concentrations were below TBC values. Lead exceeded the TBC values for TCLP analysis, and was also slightly above the established background concentration at two sample locations. The pesticide DDD was also detected at a low concentration, consistent with the past application of pesticides within Area A. The chemicals detected at this site are generally consistent with the past storage of oil and indicate that a small release may have occurred.

Health and Ecological Risk Assessment: The low concentrations of chemicals detected at this site do not cause a risk with respect to health or ecological impact.

8.1.1.2 Recommendations

No further action is recommended for this site.

8.1.2 Rubble Fill at Bunker A-86 AOC

8.1.2.1 Summary

Background: Bunker A-86 is located on a dirt road off of Wahoo Avenue in the north

central section of NSB-NLON. Area A Landfill is adjacent to the north, and the NSB-NLON hazardous waste storage facility is adjacent to the south. The rubble fill area is located to the north of the dirt access road and to the west of the bunker.

Discarded construction material is present at this site including concrete, asphalt, an electric motor, wood and gravel. Chemical containers found at this site included an empty 5-gallon container of monothanolanine (labelled as corrosive product), an empty 5-gallon container of thorite (labelled as non-shrinking compound for patching concrete), and a 55-gallon drum of lube oil that was approximately ten percent full.

Nature and Extent of Contamination: Five (5) surface soil samples were collected for analysis from this site from two sample locations to screen for contamination. Solvents (trichloroethene, tetrachlorethane) were detected in the 1-2 ppb range, below TBC values. One sample was analyzed for SVOs and contained elevated concentrations of PAHs, possibly indicative of an oil release or combustion by-products. Low concentrations of pesticides (delta-BHC, methoxychlor) were detected which are likely associated with past Area A applications. Arsenic was present at a concentration well above background levels at the one sample analyzed on a mass weight basis. The concentration of arsenic (127 ppm) was one of the highest detected compared with all other sites investigated.

Health and Ecological Risk Assessment: Activity in this area is negligible. However, based on the elevated levels of PAHs and arsenic, there could be potential health risks if exposures were to occur under some future use condition.

8.1.2.2 Recommendations

It is recommended that this site proceed to the Step II phase of the IR program. Additional soil sampling and potential ground water monitoring is recommended at this site to further characterize the nature and extent of contamination and to conduct a quantitative health and environmental risk assessment.

In the interim, it is recommended that the containers at this site be removed and properly disposed.

8.1.3 Torpedo Shops ~~AOC 5~~

8.1.3.1 Summary

Background: The Torpedo Shops are located in the northern portion of NSB-NLON on the north side of Triton Avenue. The two buildings onsite (Nos. 325 and 450) are torpedo overhaul/assembly facilities. These facilities were connected to an onsite septic system leachfield until 1983, when they were connected to municipal sewers. A variety of fuels, solvents and petroleum products are used in these buildings. Direct disposal of these wastes to the septic system was reported not to be a routine practice, although sporadic, inadvertent chemical discharges to the subsurface septic system is of concern.

Nature and Extent of Contamination: Nine surface soil samples and three ground water samples were collected and analyzed to screen for potential contamination at the former subsurface

septic systems.Low concentrations of VOCs and SVOs were detected in the north and south septic systems. Only one detection of benzene (4 ppb), was slightly above the TBC value of 1 ppb. Antimony exceeded background levels at the majority of sample locations in the south septic system, and silver was present close to or above background levels at the same sample locations. It is possible that the elevated antimony and silver are associated with a by-product of the torpedo overhaul process which occurred in Building 325. PCB was detected at 600 ppb (below TBC values) in a soil sample from the north septic system. DDE was detected at 210 ppb in a soil sample from the south septic system. The source of the PCB and DDE is unknown.

No primary drinking water standards were exceeded in the three ground water samples for VOCs or metals. No SVOs, pesticides/PCBs were detected in the ground water. Several VOCs were detected in the overburden ground water in the south septic system. These included 1,1,1 trichloroethane (42 ppb), 1,1 dichloroethene (30 ppb), and 1,1 dichloroethane (1 ppb), which were present below applicable drinking water standards. Because the soil gas survey and subsurface soil sampling within the septic leaching field did not indicate the presence of significant levels of VOCs, the presence of these solvents in the ground water suggest the potential for an undefined source. It is possible that the source of these solvents is upgradient of this location, in the vicinity of the Torpedo Shop buildings. The former hazardous waste sump, Otto fuel storage tanks, and drum storage are possible sources. Also, due to the density of these solvents, higher concentrations may be present in the bedrock aquifer. Antimony exceeded the USEPA health advisory standard in the ground water (south septic system) by over 20 times. This correlates with the elevated levels of antimony detected in the soils at this site. Because the antimony was present in the upgradient soil sample (7MW1), but not necessarily a background sample, it is unclear if the antimony in the soil/ ground water is related to septic system discharges.

Health and Ecological Risk Assessment: The potential exposure scenario relates to utility repairs/installations within the former septic system area. Based on the relatively low levels of chemicals present at the site, and the health risk calculations made for utility workers at other sites (Area A Landfill, Lower Subase), the health risks associated with this exposure scenario are qualitatively predicted to be negligible. Based on the lack of potable water supply wells for existing and projected future land use in the area, there is no exposure, therefore, no human health risks are associated with the chemical constituents in the ground water. The site is developed, therefore there are no significant ecological risks.

8.1.3.2 Recommendations

It is recommended that this site proceed to the Step II phase of the IR program. Further soil and ground water investigation is recommended at this site to define the source, nature and extent of VOC contamination, and to further address the elevated antimony at this site. No further action is required relative to the septic systems, except as they may relate to the antimony issue. The testing will be in the vicinity of the buildings and at the Otto fuel sump.

8.1.4 Goss Cove Landfill ~~AOC 5~~ A

8.1.4.1 Summary

Background: The Goss Cove Landfill site is located in the southwest portion of NSB-NLON, adjacent to the Thames River. The Nautilus Museum and a paved parking lot are constructed directly over the former landfill. The Nautilus Museum is a submarine museum operated by the Navy and open to the public.

The landfill reportedly operated from 1946 until 1957 and filled in the northern portion of Goss Cove. The southern portion of Goss Cove remains. Incinerator ash, inert rubble, and potentially other unknown materials were disposed at the site.

Nature and Extent of Contamination: A radiation, geophysical, and soil gas survey were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during drilling operations. The soil gas survey assisted in defining elevated VOCs in several areas.

Seven subsurface soil samples, four ground water and one surface water sample were collected and analyzed to screen for potential contamination.

The subsurface test boring program indicated that landfill material consisted of sand and gravel with small quantities of brick, glass, ash, wood, and metal. Minor oil stains or sheens were observed in approximately one-half of the borings, indicating some petroleum disposal/spills took place.

VOCs were detected in five of seven soil samples. Xylene was the most prevalent constituent, detected in four samples, indicative of a petroleum product. Trichloroethene and tetrachlorethene were detected in one soil sample each. Petroleum hydrocarbons (benzene, toluene), and tetrachlorethene were detected above TBC values in one soil sample each.

SVOs, predominantly PAHs, were detected at all seven subsurface soil samples, several at relatively high levels. The PAHs are likely associated with the disposal of incinerator ash and potentially associated with the presence of petroleum hydrocarbons.

PCBs or pesticides (predominantly DDT, DDD and DDE) were present individually at all sample locations. All concentrations were below TBC values except for DDT at one sample location. The presence of PCBs and pesticides are likely associated with past landfill disposal.

Many inorganic constituents exceeded established background levels, and exceed TBC values based on TCLP analysis. Arsenic, cadmium, chromium, and lead exceed both background levels and TCLP TBC values. Mercury consistently exceeded background levels at most sample locations. Elevated metals are anticipated to be related to past landfilling activities and, potentially, battery related disposal (lead/cadmium).

The highest levels of VOCs in the ground water were detected in the two downgradient wells. Vinyl chloride or benzene were present individually in the ground water at a downgradient well above ARAR values. Petroleum hydrocarbons detected (which were detected in subsurface soils) included benzene, toluene, ethylbenzene, and xylene; trichloroethene and tetrachlorethene were not present in the ground water. Low levels of SVOs are present in the ground water, primarily the more soluble PAHs, including naphthalene. Naphthalene exceeded the TBC values (USEPA Health Advisory) in a downgradient monitoring well.

Barium exceeded the primary MCL at one well; secondary MCLs were exceeded in all wells for sodium, iron, and manganese. The sodium is related to the brackish water conditions.

Gross alpha and/or gross beta radiation screening values were exceeded in two ground water monitoring wells within the landfill. These elevated readings could be the result of naturally occurring radioisotopes, but further analysis is required for confirmation.

The one surface water sample collected in the Thames River adjacent to the site did not contain VOCs, SVOs, pesticides or PCBs. Inorganic constituent values appear consistent with brackish water.

In summary, the levels of VOCs and SVOs in the subsurface soils are having some impact on ground water quality (some slightly above ARARs/TBCs), but overall the concentrations are relatively low. The elevated inorganics in soils, principally arsenic, cadmium, chromium, lead and mercury, are not adversely impacting ground water quality.

Health and Ecological Risk Assessment: Future construction and excavation activities in the parking lot could result in some risk to workers, if proper health and safety procedures are not followed. There is some potential that vapors from within the landfill could enter the museum building, however, this possibility has not been fully investigated. There is also a possibility that children could come in contact with sediments in Goss Cove. At present there are no data on the level of contaminants in these sediments.

Although ground water quality exceeded drinking water standards, no drinking water wells are within the affected area, nor could they be due to the proximity to the brackish Thames River.

Ground water from Goss Cove Landfill discharges to the Thames River. Based on the data presented in this report, a qualitative assessment indicates that contaminant concentrations in ground water at these sites are expected to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the Thames River estuary. Risks to aquatic life due to contaminants in ground water discharge from the site are also expected to be low.

8.1.4.2 Recommendations

It is recommended that this site proceed to the Step II phase of the IR program. Specifically, the following recommendations are provided.

1. Specific worker health and safety provisions are recommended for all future subgrade construction projects at the site. Prior to construction in specific areas, further subsurface investigation should be conducted to characterize the quality/ disposal and health and safety requirements of the material to be encountered.

2. The geophysical survey indicated the presence of buried metal objects at three locations as specified in Section 4.0. Any future planned construction near these areas should include exploratory excavation in these areas to identify construction health and safety requirements.

3. It is recommended that several borings/soil analyses be conducted in the area closer to the Nautilus Museum and remaining Goss Cove. This should be performed in conjunction with indoor air quality measurements within the Nautilus Museum building to assess potential health risks.

4. A quantitative health and environmental risk assessment of the potential impact of the site on the Thames River should be conducted to verify the qualitative assessment that impacts appear negligible. This would include surface water samples at low tide (ground water discharge) conditions, sediment sampling, and biota survey/sampling along the Thames River and Goss Cove shoreline.

5. Conduct another ground water sampling and analysis round for TCL organics and TAL inorganics to confirm the analytical results. Also, perform specific radiological isotope ground water analysis to determine the source of the radiological constituents (natural or otherwise).

8.1.5 OBDANE

8.1.5.1 Summary

Background: The Over Bank Disposal Area Northeast (OBDANE) site is located in a heavily wooded area on the edge of a ravine northwest of Area A Landfill, and south of the Torpedo Shops. Inspections of this site have indicated the presence of several empty fiber drums in this area. No visual staining or stressed vegetation was observed.

Nature and Extent of Contamination: Five (5) surface soil samples were collected for analysis from this site, from two sample locations, to screen for potential releases at this site. One surface soil sample contained tetrachlorethene at 2 ppb, below the TBC value. No SVOs, PCBs, or pesticides were present. No inorganic compounds exceeded established background levels or TBC levels based on TCLP analysis.

Health and Ecological Risk Assessment: This site appears to pose a negligible risk based on the lack of activity and the low concentration of chemicals.

8.1.5.2 Recommendations

No further action is recommended at this site.

8.1.6 Spent Acid Storage and Disposal Area

8.1.6.1 Summary

Background: This site is located in the southeastern section of NSB-NLON, between the southern side of Buildings 409 and 410. A 4' x 4' x 12' long rubber-coated underground tank was used for temporary storage of waste battery acid around World War II. The tank top is still visible, but has been filled with earth and capped with concrete.

Nature and Extent of Contamination: Seven subsurface soil samples were collected to screen for potential release of battery acids from the subsurface tank. High levels of lead were present in six of seven soil samples based on TCLP analysis. Four samples are classified as a RCRA hazardous waste due to the lead concentrations. These samples were collected at the 0-4 foot depth interval. Several soil samples also had low pH values. The elevated levels of lead and low pH values substantiate that a release of battery acid likely occurred. The present level of subsurface investigation has not defined the extent and degree of contamination.

Health and Ecological Risk Assessment: The area between Buildings 409 and 410 is scheduled for construction of a new building. There may be some risk to construction or utility maintenance personnel associated with contact with contaminated subsurface soils if they do not follow appropriate health and safety procedures. Based on similar levels of lead at DRMO, and the resulting risk for construction workers (Hazardous Waste Storage Building Construction), the risks at this site to unprotected construction workers could be above acceptable levels. The site is developed, therefore, there are no significant ecological risks.

8.1.6.2 Recommendations

It is recommended that this site proceed to the Step II phase of the IR program. Further subsurface soil investigation is recommended to characterize the extent of contamination in this area for possible remediation. A ground water quality investigation is also recommended to assess potential lead contamination, particularly in light of the low soil pH values, which may tend to make the lead more mobile. Should construction in the area be required, appropriate worker health and safety procedures should be developed.

8.1.7 Former Gasoline Station

8.1.7.1 Summary

Background: The former gasoline station site is located in the roadway and parking area just south of Building 164 (Dealey Center). The gasoline station operated from 1940 to the early 1960s. Several underground gasoline tanks and a waste oil tank existed onsite.

Nature and Extent of Contamination: The geophysical investigation identified the potential presence of one underground gas tank which appears to remain on the site. The soil gas survey did not detect the presence of significant VOC constituents, although organic vapor field measurements of subsurface soil samples indicated levels above background.

Five subsurface soil samples were collected from five test borings to screen for potential releases from the former gasoline station. Only one soil sample, located adjacent to the identified gas tank, contained VOCs. Trichloroethene and benzene were detected below TBC values. No metals exceeded established background concentrations, although three soil samples contained arsenic exceeding the TBC value based on TCLP analysis. The arsenic TCLP results do not appear significant, as arsenic concentrations do not exceed background values based on mass weight analysis.

Health and Ecological Risk Assessment: No risks are identified under existing conditions based on available data. Appropriate health and safety precautions should be followed during tank removal to confirm that no contamination is present. The site is developed, therefore, there are no significant ecological risks.

8.1.7.2 Recommendations

It is not recommended that this site proceed to the Step II phase of the IR program. However, it is unlikely that the potentially identified underground gasoline tank was abandoned in accordance with current requirements (e.g., cleaning/filling with inert material). It is recommended

that the tank be removed, and at the time of removal, confirmation soil samples be collected and analyzed from the tank grave. If no contamination is identified at that time, then no further action would be recommended at this site.

8.2 Step II Sites

8.2.1 Area A/OBDA

8.2.1.1 Summary

Background: The **Area A Landfill** is located in the northeastern and north-central section of NSB-NLON. It is approximately seven acres in size. Access is via a dirt road off Wahoo Avenue. The Area A Landfill is a relatively flat area bordered by a steep, wooded hillside that rises to the south, a steep wooded ravine to the west, and the Area A Wetland to the north. Aerial photographs show that the landfill appears to have extended east along the wetland to as far as the present position of the tennis courts. Runoff from the landfill drains as overland flow north into the Area A Wetland, which subsequently discharges to the Area A downstream watercourses and into the Thames River.

The landfill opened sometime before 1957. The base incinerator ceased operating in 1963, and from 1963 to 1973 all wastes were disposed in the landfill unburned. During this time, all non-salvageable materials generated by the submarines and base operations were disposed in the Area A Landfill.

Landfilling operations ceased in 1973. After closure, a concrete pad was constructed in the southwest portion of the landfill for above ground storage of industrial wastes. At the time of the IAS survey, 42 steel drums, 87 transformers (mineral and PCB), and 60 to 80 electric switches were stored on the pad. Two transformers and several electrical switches were leaking. Past leakage of oil was also evident. Most drums were stacked on wooden pallets and those having PCB labels were covered and bound with plastic sheeting. All of these materials have since been properly disposed offsite.

Sand bags and contractors' supplies and equipment have, in recent years, been stored over the former landfill. Several transformers, removed underground storage tanks, crane weights, and other equipment are stored on the concrete pad in the southwest portion of the landfill. The specific items stored in this area vary. The remainder of the landfill is not paved.

The construction of a paved parking lot on the southeast end of the Area A Landfill was planned, but has been delayed indefinitely.

The **Area A Wetland** abuts the north side of the landfill and is approximately 30 acres in size. The maximum wetland sediment thickness is approximately 35 feet, based on boring information. Until 1957, this portion of the site was undeveloped, wooded land. In 1957, dredge spoils from the Thames River were pumped to this area and contained within an earthen dike that extends from the Area A Landfill to the south side of the Weapons Storage Area. Atlantic learned during the course of this study that, previously, pesticide "bricks" were placed on the wetland ice during winter and allowed to melt and discharge into the wetland for mosquito control.

Several construction projects are planned for the Weapons Storage Facility at the north end of the Area A Wetland. The facility was constructed partially on the dredged fill material and settlement has occurred in several areas. Routine maintenance and security improvements that are planned include grouting and waterproofing bunkers, repaving roads, and the installation of culverts and regrading associated with these activities. The Navy also plans to build more magazines and bunkers in this area within ten years.

The **Area A Downstream Watercourses** drain the Area A Landfill and Wetland and ultimately flow into the Thames River. The Area A Downstream Watercourses include North Lake and several small streams which discharge from Area A and the Torpedo Shop and ultimately discharge to the Thames River.

Ground water also discharges from Area A to a small wetland at the base of the dike and the Over Bank Disposal Area site. A stream flows from this wetland west toward North Lake, a recreational swimming area for Navy officers. Under normal flow conditions, the stream enters a culvert which bypasses the pond and discharges to a stream below the outfall of the pond. This stream flows west under Shark Boulevard and through the golf course to the Thames River. There is a manhole adjacent to North Lake, that connects to another pipe, which was designed to discharge overflow water from North Lake. Under substantial runoff conditions, however, it is possible that some water discharges to the pond from this stream.

Further development is not planned for this area.

The Over Bank Disposal Area (OBDA) is located on the slope of the dike below and adjacent to the Area A Landfill. A small wetland exists at the base of the dike.

This area was a disposal site after the earthen dike was constructed in 1957. In 1982, it was the finding of the previous studies that the material had been there for many years and included 30 partially covered 200-gallon metal fuel tanks and scrap lumber.

Atlantic personnel inspected the site in September 1988, and observed approximately 30 empty, unlabeled 200-gallon tanks, old creosote telephone poles, several empty unlabeled 55-gallon drums, and rolls of wire. Bright orange, organic sediments were observed in the water discharging from the base of the dike embankment, apparently leachate from the landfill.

Area A Landfill-Nature and Extent of Soil Contamination: A radiation, geophysical and soil gas surveys were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during drilling operations. The soil gas survey detected VOCs, predominantly petroleum hydrocarbons, in the deployed parking area.

VOC concentrations in the subsurface soil within Area A Landfill are generally low. No TBC values for VOCs in soil samples were exceeded. One surface soil sample collected near the concrete storage pad did contain elevated levels of petroleum hydrocarbons. SVOs, principally PAHs, were detected at relatively low levels in some of the landfill subsurface soil samples. The results of the SVOs analyses at Area A Landfill are significantly lower than at the DRMO and Goss Cove former landfill sites. The organic results, in general, do not indicate significant disposal of organic chemicals within the Area A Landfill.

No PCBs were detected in the subsurface soils within Area A Landfill. One surface soil sample contained PCBs above the TBC concentration of 10,000 ppb. This soil sample was collected adjacent to the concrete storage pad where drum storage, PCB transformers, and electric switches were once stored. The potential extent of the PCBs in this area was not defined based on the two surface soil sample locations.

Pesticides were detected at three subsurface sample locations (2LMW7S, 2LMW8S, and 2LMW18S) at Area A Landfill. DDTR were detected at these locations at relatively low concentrations and are below TBC values. The DDT was present above the TBC value of 500 ppb at one surface soil sample near the concrete storage pad.

Out of the 12 subsurface samples analyzed by TCLP analysis procedures, ten contained one or more metals exceeding TBC values. Metals exceeding TBC values included arsenic, cadmium, lead, and selenium. TCLP hazardous waste characteristic values were not exceeded for any samples. Some inorganic constituents exceeded established background levels based on mass weight analysis, including beryllium, cadmium, lead, and mercury. Other metals exceeding background levels included copper, nickel and boron. The majority of these elevated metals are likely related to a past landfill disposal.

The lead and cadmium values are generally low, and are not indicative of the existence of a significant source such as the reported historical battery acid disposal in this area. Levels of cadmium, and particularly lead, were much higher at the Former Acid Storage and Disposal Site and DRMO, where battery acid storage tanks existed.

Area A Wetland-Nature and Extent of Soil and Sediment Contamination: VOC concentrations in the subsurface soil and sediment within Area A Wetland are in the low to moderate range. VOCs are generally spatially distributed throughout the wetland area and generally present at uniform concentrations with depth. This is consistent with the origin of the sediments, from the Thames River dredge materials, deposited in the wetland. VOC TBCs exceeded included benzene (one sample), trichloroethene (three samples) and tetrachloroethene (four samples). The source of the VOCs in the wetlands subsurface soils would appear to be associated with sediments originally contained from the Thames River, and/or absorption of ground water chemicals onto the sediments. The origin of the VOCs in the sediments could be from several sources, including those mentioned above, runoff from the Weapons Center, and general urban runoff. The samples collected near the landfill did not contain any VOCs above TBC values.

SVOs, principally PAHs, were detected at generally low levels in most of the wetland sediment and subsurface samples. Overall SVO concentrations were slightly higher in the 0-2 and 10-22 feet reporting intervals, although this may be attributable to the smaller number of samples collected in the 2-10 foot interval. The highest concentration of SVOs was detected within a drainage swale at a stormwater discharge location of the Weapons Center. The Verification Study sediment sampling of another stormwater culvert discharge location near the Weapons Center also indicated the presence of PAHs. Sediment samples recently collected from the Thames River also contain low levels of PAHs, consistent with the levels in the Area A Wetland.

PCBs (Arochlor 1260) were detected at two sample locations, but were below the TBC value. The source of the PCBs in the wetland near the landfill appears related to transport of

contaminated surface soils from Area A Landfill. The source of the PCBs detected at the Weapons Center is unknown.

Pesticides (DDTR) were detected at five sample locations in the 0-2 foot reporting interval. Based on detection in the 0-2 foot interval, these appear to be related to the past reported surface application of pesticides at the wetland area. The pesticide detections were less frequent and the concentrations much less than for the samples from the Area A downstream watercourses. This may be related to the potential for higher concentration of pesticides present at locations not sampled (pesticide bricks were reportedly applied at point locations), and/or due to compositing of the samples. This may be supported by previous sediment sampling conducted within the wetland near its outlet and at an upgradient location (east side), which contained DDTR in the 17,000 ppb range. Alternatively, it could indicate more substantial application of pesticides in the downstream watercourse area.

In general, metal concentrations within the wetland subsurface soil and sediment samples were low. A total of 35 soil and sediment samples were collected within the wetland proper, with the remainder collected at adjacent locations. Several samples contained slightly elevated levels of lead (7), mercury (3), cadmium (1), and silver (2). Several samples exceeded TBC values based on TCLP extraction procedure. These included arsenic, cadmium, chromium, lead, selenium, and silver. Only two samples had metal values (lead, silver) which exceeded both established background concentrations and TBC values based on TCLP analysis. The elevated metals are likely associated with the origin of the sediment from the Thames River. Cyanide was detected at the drainage outlet from the Weapons Center. The previous Verification Study also reported cyanide at another surface water discharge location from the Weapons Center. These detections of cyanide, and the elevated PAHs, suggest a possible source of contaminants at the Weapons Center. The elevated levels of cyanide and PAHs suggest that spent Otto fuel may be the cause of this contamination, however, the specific source is unknown.

Area A Downstream/OBDA-Nature and Extent of Soil and Sediment Contamination: The subsurface soil samples were collected at well locations which were in wooded undeveloped areas where no past disposal was reported or apparent. The exception was 3MW12S, which was located adjacent to the wetland at the Over Bank Disposal Area, where past disposal is evident.

Trichloroethene (24 ppb) and tetrachloroethene (58 pp) were detected at a subsurface soil sample location near North Lake, both of which are above TBC values of 5 ppb. Low levels of toluene and 1,1-dichloroethene were also detected. The source of the solvents detected near North Lake is unknown. One possibility is an unconfirmed report from a retired Navy employee who stated that there was a past disposal area in this general vicinity. This could not be confirmed based on review of aerial photographs and discussions with other Navy personnel.

No SVO compounds were detected in subsurface soils, except for low levels of phthalates at one sample location. Low levels of SVOs, principally PAHs, were present in a subsurface soil sample at OBDA, which correlates with SVOs detected in the sediment samples at OBDA.

No PCBs were detected in the subsurface sample points. Pesticides, DDT and its derivatives, were detected in a subsurface soil sample near OBDA and at a sample near North Lake. The detection of pesticides at these locations appears related to past pesticide application in Area A. No significant detections of inorganics were noted in the subsurface soil samples.

Twenty-three sediment samples were collected for analysis from the OBDA wetland, the Area A downstream watercourses and associated ponds, and North Lake. The purpose of the sediment sampling and analysis programs was to assess the extent of sediment contamination (principally pesticides) within this area, due to past application and sediment transport from potential source areas. Previous analysis of sediments in this area indicated the presence of pesticides and metals.

No VOCs were detected above TBC values for samples collected. At sample locations near the outlet of Area A wetland, low levels of VOCs (methylene chloride, trichloroethene) were detected, indicating some limited migration of VOCs via sediment transport from Area A wetland. Within OBDA, all sediment samples contained low levels of VOCs, but below TBC values. VOCs detected include methylene chloride, 2-butanone (methyl ethyl ketone), tetrachloroethene, toluene, ethylbenzene, and xylene. This indicates that some past releases of solvents and petroleum hydrocarbons occurred at the OBDA site. These VOCs could also be partially attributable to adsorption of chemicals to the sediments from ground water. Low to moderate levels of SVOs were detected in most sediment samples.

The only detection of PCBs was at 2DSD12, which is at the outlet of the downstream watercourse, at the Thames River, adjacent to DRMO. Based on the elevated levels of PCBs at the DRMO site, it appears likely that this is associated with surface water runoff from the DRMO site and not Area A.

Pesticides (DDTR) were detected at moderate to very high concentrations within the Area A downstream watercourses and ponds. No pesticides were detected in the North Lake sediments. The TBC value was exceeded at ten of the 23 sample locations. The highest concentrations were detected in the two ponds below the Area A dike, and within the OBDA sediments. Based on these concentrations being much higher than those found within Area A wetland, this may be due to pesticides application rather than sediment transport. High concentrations in these areas suggest that substantial quantities of pesticides were applied in this area. Lower concentrations downstream of these areas and extending to the Thames River are likely attributable to sediment transport from the higher concentration areas. The data indicates that some ongoing migrations of pesticides, due to sediment transport, to the Thames River is occurring from the pond source areas.

Several metals were detected above established background levels. These occurred in samples closest to the Area A wetland area. They included beryllium, cadmium, lead, selenium, zinc and boron. Cadmium was not detected above background levels in the Area A wetland sediments, therefore, the cadmium source does not appear to be related to sediment transport from the wetland. No metals were detected above background levels in North Lake sediments.

Ten sediment samples were collected from the OBDA area. Sediment samples contained metals above established background levels for cadmium (3), iron (2), lead (4), selenium (2), and zinc (2). Cadmium results based on TCLP analysis correlated with mass weight analysis for two samples. TCLP analysis detected no lead. The elevated iron concentration may partially explain the rust colored leachate that is visible in this wetland area and within the stream bed. The lead and cadmium may suggest battery/battery acid disposal in this area, which were the highest concentrations recorded throughout Area A. Alternately, it could be related to the cadmium present in the ground water at this location, and adsorption onto the sediments as it discharges to OBDA.

Area A-Nature and Extent of Ground Water Contamination: Twenty-eight ground water monitoring wells were installed and sampled within Area A, which includes the landfill, wetland, and downstream areas. Eleven were water table overburden wells and 17 wells were installed and screened in the bedrock aquifer.

VOCs were detected in only six of 28 monitoring wells within Area A. Of the six, only three locations exceeded TBC/ARAR values for drinking water. The solvent trichloroethene was detected above drinking water standards (ARARs) at 2LMW13D (10 ppb) at the west end of the landfill, and 2DMW16D (17 ppb) upgradient of North Lake. These are both bedrock wells. This suggests a low concentration plume of solvents within the bedrock aquifer extending from the western portion of the former landfill downgradient to the North Lake area. The ground water does not appear to discharge to North Lake, based on the vertical head gradient information at 2DMW16S&D. The plume appears to be fairly narrow, as no solvents were detected in the Area A downstream wells to the north. This is supported by review of the ground water specific conductivity data which is used as a landfill leachate indicator. Solvents were not detected in downgradient well 3MW12D (OBDA), suggesting preferred fracture flow is occurring in the bedrock aquifer. However, this does not correlate with the cadmium data, which indicated elevated levels of cadmium at 2LMW13S and 3MW12D. The downgradient extent of the solvent plume is undefined, which is flowing in a westerly direction. Benzene was detected at 10 ppb, above drinking water standards (5 ppb) at 2LMW18S, which may be related to the parked vehicles in this area; it was not detected in any other well in Area A.

Overall, the VOC concentrations for those wells where detected are low, given the historical use of Area A as a landfill. Although drinking water ARAR/TBC values are exceeded in three wells, the results do not indicate any significant ongoing release of VOC contaminants. Based on the soil gas and subsurface soil data, low levels of petroleum hydrocarbons and solvents are present throughout much of the Area A landfill area. This suggests a generally uniform-low level of soil contamination within the landfill, and no substantial source area. The deployed parking area and adjacent area to the east (also used for automobile storage/parking) exhibited the most uniform level of petroleum hydrocarbons based on soil gas data.

PCB was detected in the ground water at one location within the landfill. The concentration exceeded its solubility and further sampling of the well would be required for confirmation of the result.

Cadmium was the only inorganic compound which exceeded primary drinking water standards (ARARs) within Area A. Cadmium was also detected in one instance above drinking water standards at a residential well located east of Area A. Cadmium was detected above the 10 ppb drinking water standard at 2WMW3S (10.6 ppb), 2LMW18S (29.1 ppb), 2LMW13D (44.8 ppb), and 3MW12D (16 ppb). The source of these elevated levels of cadmium may be related to soils within the landfill and, possibly, OBDA. However, cadmium soil concentrations in the landfill only exceeded established background levels at one sample location (2LMW8S). It is possible that higher concentrations of cadmium exist in the landfill, at locations other than the sample points. Dissolved cadmium levels in Area A ground water may be partially attributable to low pH values for some wells. The upward ground water vertical head gradient within most of the landfill should minimize the transport of cadmium to the bedrock aquifer from an apparent landfill source. However, at bedrock well 2LMW13D, where there is a strong upward vertical head, the cadmium is present in the bedrock system, from a source either upgradient within the landfill, or another

unknown upgradient source. The former Weapons Center is upgradient of this area along Wahoo Avenue, however, the lack of elevated levels of cadmium in other nearby bedrock wells (2LMW9D, 2LMW17D, and 2LMW14D) does not strongly support an offsite source, but rather a landfill source.

The overburden ground water flow along the central and eastern portion of the landfill is toward the wetland, and along the western portion of the landfill to the northwest, down the Area A downstream watercourse valley. Therefore, the cadmium ground water contamination appears confined to the landfill and the OBDA area. Cadmium was only detected in well 3MW2D in the OBDA, suggesting a potential confined plume to the northwest although, due to preferred bedrock flow patterns, other wells may not have intercepted the cadmium and, therefore, the cadmium plume may be undefined.

Of importance to this study is the direction of bedrock ground water flow in this area, due to the detection of cadmium in several offsite residential wells to the east of Route 12. Inspection of the bedrock ground water contour map indicates that the residential wells along Route 12, Baldwin Hill Road and North Pleasant Valley Road are upgradient of Area A, and would not be affected by conditions at the site. Most of these wells had bedrock ground water elevations substantially higher than wells containing cadmium in Area A (2WMW3D, elevation 76 feet). However, residential wells near the NSB-NLON east gate, southeast of Area A, had bedrock water elevations (75-80') in the same range as 2WMW3D, the closest bedrock well in Area A. Therefore, based on the available data, it is indeterminate if these wells are upgradient or downgradient of the western portion of the Area A Landfill, however, cadmium does not exceed drinking water standards in these wells.

Iron and manganese exceeded secondary drinking water standards in many Area A wells. The results for 2WMW1D and 2WMW2D (upgradient wells) and the residential well analytical results were much lower for iron and manganese, which indicates a source of these inorganics within the Area A landfill material and wetland sediments.

Radiological screening parameters were exceeded in nine of the 20 samples. These occurred at three within the landfill area; one near the Weapons Center; and four within the Area A downstream area. These elevated readings could be the result of naturally occurring radioisotopes which do not meet the gross screening criteria. Further sampling and analysis is required for confirmation.

Residential Well Analytical Results: A residential well sampling and analysis program was conducted to assess ground water quality in offsite areas near Area A.

The first round sampling indicated low levels of chloromethane, methylene chloride, and xylene at OSW15 (16 Sleepy Hollow), but below drinking water standards. This well was resampled for VOCs in the second round and none were detected. The first sampling round indicated the presence of cadmium at OSW6 (1458 Route 12) above primary drinking water standards (10 ppb) at a concentration of 26.3 ppb. Other compounds (iron, manganese, aluminum and sodium) were detected in other wells which exceeded secondary drinking water standards, and are attributable to natural ground water conditions.

Due to the presence of cadmium, a second sampling round was conducted to expand the sampling program to areas east of Area A on Route 12, North Pleasant Valley Road, and Baldwin Hill Road. The second sampling round did not detect any metals above primary drinking water standards. Also, cadmium was not detected at 1458 Route 12, where it was previously present. Cadmium was detected at low levels at five of 13 wells sampled in the 2.1-3.1 ppb range, below the 10 ppb standard. As previously discussed, an assessment of the ground water hydrogeology of this area indicates that the presence of cadmium in the offsite residential wells is not attributable to the detection of cadmium within Area A at NSB-NLON, with the possible exception of well OS25 to the southeast, which contained cadmium below standards, but could be downgradient of Area A Landfill.

The cadmium detected within the residential sample area appears to be a natural background concentration in the ground water. A further round of residential well sampling is planned to further confirm the analytical results.

Nature and Extent of Area A Surface Water Contamination: Fifteen surface water samples were collected within Area A, including the wetland, downstream areas and Thames River. These samples were collected to assess the surface water quality.

Low levels of VOCs were detected at several sampling points 2DSW5, 2DSW7, 2DSW8, 2DSW12, and 2DSW13. Except for one sample, constituents detected are petroleum hydrocarbons and could be associated with runoff. One sample near Triton Avenue contained 3 ppb of tetrachlorethene and 2 ppb of styrene. No ARARs or TBCs were exceeded for the VOCs. No SVOs were detected at any of the sampling locations.

No pesticides or PCBs were detected at any of the sampling points except for 2DSW4, which contained 1.9 ppb of DDD. This sample is in the area where high levels of DDTR, including DDD, were detected in sediments. It is likely that the origin of DDD in the surface water is from the sediments. There are no ARAR values in surface water for DDD.

. ARARs/TBCs for inorganics were exceeded at several sample locations for cadmium (3 of 15), copper (4 of 15), iron (11 of 15), lead (8 of 15), manganese (13 of 15), and mercury (1 of 15). These ARARs are based upon in-stream water quality criteria to protect aquatic life and may not be appropriate to the wetlands and small drainage streams. The presence of iron and manganese in surface water may be a result of the low pH and reduced conditions created by the Area A Landfill. Some of the iron and manganese may originate from wastes, however, the majority of what is detected in surface water is probably being leached from native soils. Of note are the ARAR exceedances in the Thames River at sample locations 2DSW12 for manganese and iron, and at 2DWS13 for manganese. Area A upstream surface water samples also contained elevated levels of iron and manganese, whereas surface water samples in the Thames River at DRMO and Goss Cove did not contain levels above ARARs. The iron standard of 1000 ppb is based on chronic aquatic toxicity water quality criteria and the manganese standard is based on water quality criteria for human health risks from fish consumption.

Copper, which exceeded water quality criteria, was also detected in concentrations above background at six locations in the Area A Landfill soils. It is assumed that the elevated concentrations originate from the Area A Landfill.

Cadmium and lead are present above ARARs and levels normally seen in natural surface waters and are present both in the Area A wetlands and landfill soils and sediments. The presence may be the result of historical disposal activities. However, cadmium and lead were also detected in the upgradient sample location (2LSW1) above ARARs.

Mercury was only detected in one surface water sample (2DSW9). This location (adjacent to Triton Road) is immediately downgradient of two sediment sampling locations where mercury was found. Although these two sediment mercury concentrations were below background, mercury was not detected in any other sediment samples. There was one occurrence of mercury above background concentrations in Area A Landfill soils. Mercury is rarely found in natural surface waters above 1 ppb. The source of the mercury in sediments is not apparent, however, historical disposal in Area A Landfill is possible. However, it is more likely that a past release upgradient of sample locations 2DSD7 and 2DSD8 along Triton Road occurred. It is noted that sediment sample 7SD1, within a runoff swale from the Torpedo Shop, contained no mercury, nor did any other soil or ground water sample at the Torpedo Shop, which implies that the Torpedo Shop is not the source.

All of the radiological results were below ARAR screening values.

Human Health Risk Assessment: Several identified exposure pathways were evaluated for Area A. They are listed as follows:

- Workers repairing utilities within Area A;
- Weapons Center personnel exposed to fugitive dusts from Area A Landfill;
- Workers moving pallets within Area A Landfill;
- Navy personnel exposed to fugitive dust while engaged in recreational activities near Area A Landfill;
- Groton/Ledyard residents exposed to fugitive dust from Area A Landfill;
- Citizens attending car auctions at Area A Landfill;
- Subase children exploring woods within Area A;
- Subase children exploring streambeds and Area A Wetland; and
- Children swimming in North Lake.

Negligible or *de minimus* risks were calculated for workers repairing utilities within Area A, Weapons Center personnel exposed to fugitive dust, Navy personnel exposed to fugitive dust while engaged in recreational activities, citizens attending car auctions, and children swimming in North Lake.

The following exposure scenarios did exhibit risks which fell within the one in one hundred thousand to one in one million excess cancer risk range:

- Workers moving pallets within Area A Landfill (risk due to presence of PCBs in landfill surface soils);
- Subase children exploring woods within Area A (risk due to PCBs in landfill surface soils); and
- Subase children exploring streambeds and Area A Wetland (risk due to pesticides in stream sediments).

Ground water within Area A contains VOCs and cadmium above ARAR and TBC drinking water standard/guidance values, indicating a potential health risk if the water were to be consumed. No potable water supply wells exist, or are planned by the Navy, in the potentially affected downgradient area. The Navy owns the land within the potentially affected area. Therefore, under existing and projected future land use conditions, no exposure pathways exists for human consumption of degraded ground water.

Ecological Risk Assessment: The ecological risk assessment addressed risks to a variety of trophic levels in the terrestrial and aquatic food chain in Area A. On the lower level of the food chain, risks to plants were low. Plants are unlikely to accumulate organic compounds to a great degree. Metals concentrations in soils and sediments were, in general, below levels that may adversely affect plants or higher trophic level organisms that feed on plants. However, cadmium concentrations in soil samples from the OBDA exceeded recommended levels protective of plants and organisms consuming plants.

Risks to terrestrial organisms due to DDTR in soil were greatest for soil invertebrates in the OBDA. The risks to soil invertebrates in the wetland and downstream areas due to contaminants were low.

The assessment indicates that DDTR in sediments of streams and ponds in the Downstream Watercourse Area poses a potentially great risk to biota. Organisms with the greatest exposure to DDTR contaminated sediments are benthic invertebrates. Frogs are also directly exposed to sediment during winter months. Other organisms potentially affected by these sediments are fish, if they are present in the ponds. Birds such as ducks, heron, and mammals such as raccoons and otter, may be exposed to DDTR by feeding on contaminated aquatic invertebrates and frogs, but this exposure will only account for a small part of their diet because they are likely to feed over a much greater geographical area than Area A.

Higher level organisms in the food chain may be exposed to the DDTR and, to a lesser extent, to PAHs bioaccumulated in soil invertebrates. The greatest potential risks are to small mammals such as the shrew that consume a diet consisting mainly of soil invertebrates at a rate equivalent to their body weight per day. Based on the assumption that they consume only contaminated soil invertebrates, there are potential risks to these animals. Risks to herbivorous birds and small mammals are much smaller than for the maximally exposed shrew since they have much less exposure to DDTR. Based on the low body burdens of DDTR in catbirds collected from Area A, risks to birds feeding on soil invertebrates appear to be low. This may be because the area they feed in is large in comparison to the portion of the OBDA with elevated levels of DDTR in soil.

The aquatic organisms in Area A at greatest risk are those exposed to elevated levels of DDTR in pond and stream sediments in the Downstream Watercourse Area. Therefore, benthic invertebrates and possibly frogs are at greatest potential risk. DDTR contaminated sediments have been transported by the streams in the downstream portion of Area A to the Thames River. However, DDTR concentrations and, therefore, potential risks due to DDTR are much lower at the stream outfalls than upstream.

8.2.1.2 Recommendations

It is recommended that this site proceed to the Feasibility Study phase to address the health and ecological risks identified. Additional data is recommended to be collected concurrent with the Feasibility Study to further assess several site conditions for input to the FS. Recommendations and data requirements are provided below.

Landfill Soils

- Further soil sampling is recommended around the Area A concrete pad (former hazardous waste storage area) to define the full extent of contamination identified in that area.

Wetland Sediments

- Further sediment sampling is recommended in the Area A Wetland to confirm the relatively low levels of pesticides detected compared with Area A Downstream sediments. Sampling in the pond and open water area near the wetland outlet is also recommended. This data is required for the Feasibility Study and further ecological assessment. The pond information would better allow assessment of risks to biota in these areas and to compare measured body burdens of DDTR in frogs from the wetland pond to sediment DDTR concentrations.

Ground Water

- Conduct another ground water sampling and analysis round for TCL organic and TAL inorganic parameters to confirm the analytical results. Also, perform specific radiological isotope ground water analysis to determine the source of the radiological constituents (natural or otherwise).

- The extent of VOC and cadmium ground water contamination in Area A Downstream should be defined and monitored.

- Further assessment of the ground water flow direction in the area of the southeastern portion of the landfill is required with respect to the homes served by private wells near NSB-NLON east gate. This would require the installation of additional monitoring wells in this area, and surveying the elevation of the water in the private wells.

- Another round of ground water sampling has been conducted for offsite residential wells in which cadmium has previously been detected. The results are pending.

Weapons Center:

- Further assessment of the source of elevated levels of cyanide and PAHs adjacent to the Weapons Center is recommended.

North Lake

- Surface soil sampling around the North Lake area is recommended to determine if contamination is present due to past pesticide application in the general area. This is recommended to assure the safety of use of North Lake as a recreational area. Continued monitoring of North Lake is recommended should the lake remain open for public use. Should the lake remain open, access to the downstream watercourse areas should be restricted.

Downstream Watercourses and Pond

- The ecological assessment was based on a limited number of surficial soil samples from the Area A Downstream Watercourse Area. At the time of designing the sampling program, it was unknown that DDTR levels would be the most elevated in this area. To gain a greater level of confidence in this assessment, we recommend additional surficial soil sampling and analysis in the downstream watercourse area.

- Additional information is required on biological conditions in the Area A Downstream Watercourses where elevated levels of DDTR were detected in pond and stream sediments. No biota sampling was performed in these areas. The assessment predicts risks to benthic invertebrates and possibly to frogs in these areas. To supplement this assessment with actual field data, additional field work is recommended to assess the biological community in the ponds and streams where DDTR was detected at elevated levels in sediments.

Thames River

- Pesticides are being transported to the Thames River. Although the levels in the river sediments detected to date are not high, further delineation is recommended to further evaluate this condition. Manganese has also been detected in the Thames River surface water samples at the outlet of Area A in concentrations above water quality criteria. In light of these facts, further ecological assessment of the Thames River, similar to that recommended at Goss Cove, DRMO, and Lower Subase is recommended to provide greater assurance regarding the current assessment of ecological risks. This assessment should consider the potential cumulative effects of NSB-NLON on the river.

8.2.2 DRMO

8.2.2.1 Summary

Background: The Defense Reutilization and Marketing Office (DRMO) site is adjacent to the Thames River in the northwest section of NSB-NLON. The DRMO is the storage and collection facility for items to be sold at auction sales held periodically through the year. Scrap metal is also temporarily stored prior to being transported off this site.

The DRMO site was used as a major base landfill and burning ground from 1950 to 1969. The materials burned and landfilled included construction materials, combustible scrap, and other non-salvageable waste items. These materials were reportedly burned on the shoreline, and disposed over the riverbank and partially covered. Also, a former battery acid handling facility was located adjacent to Building 491. An in-ground rubber-lined tank and associated pumping facilities were present, similar to the Spent Acid Storage and Disposal Area site.

DRMO operations at this site, after the closing of the landfill, include storage of various items, including submarine batteries, white goods, and empty drums.

Future plans for this site include the construction of a Conforming Storage Facility for the temporary storage of hazardous waste generated at NSB-NLON. Other routine grading and minor excavation occurs in the northern portion of the site.

Nature and Extent of Contamination: Radiation, geophysical and soil gas surveys were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during drilling operations. The soil gas survey assisted in defining VOCs in several areas.

Twenty-four soil samples were collected, from 12 test boring/monitoring well locations. Four surface soil samples were also collected. Six ground water samples were also collected and analyzed. These samples were analyzed to define the nature and extent of contamination at the former landfill site.

Some evidence of the former landfill was encountered during the drilling, including wood fragments, brick, metal, but predominantly earth fill material. The depth of fill varied from zero to eight feet.

VOC concentrations in soil at DRMO are generally low. However, many soil samples exceed TBC values for VOCs. Elevated VOCs were detected at 6TB4 (6-8'), where the following was found: vinyl chloride (1300 ppb), trichloroethene (20,000 ppb), and tetrachlorethene (210 ppb). The contamination appears to be generally isolated at the site based on results of the soil gas survey and other soil samples collected in this area.

SVOs were present in most samples collected in the former landfill area. The SVOs were predominantly comprised of PAH compounds, many of which were at elevated levels. The spatial density of the sample locations indicates that PAHs are likely present throughout the DRMO site limits. Based on the former use of the site as a landfill, and an area where material was burned, the PAHs are likely a result of incomplete combustion and, perhaps to a lesser degree, due to petroleum releases.

PCB Arochlor 1260 is present at almost all sample locations except 6MW5S (background), and 6MW1S and 6MW2S (rear of office and storage building). Concentrations range from 52 ppb to 12,000 ppb. It is generally present in both the 0-2' and 2-6' depths. The presence of PCBs at this site is most likely associated with scrap metal storage (e.g., white goods) and associated capacitor leaks, and past storage of transformers, and not necessarily due to landfill disposal. PCB (Arochlor-1260) was also detected at sediment sample location 2DSD12, at the outfall of the storm drainage system from Area A, to the rear of Building 397 at DRMO. It was not present in other

upgradient sample points along the Area A downstream watercourses, and may be a result of surface soil transport via surface water runoff from DRMO.

Pesticides were detected at one sample location at elevated concentrations; no other pesticides were detected at other sample locations. Total pesticide concentration was 57,800 ppb, consisting of DDT, DDD and DDE. The DDT concentration was detected above the TBC value. Due to pesticide detection at only one sample location and at a depth of 2-6 feet, it was likely associated with past landfilling rather than application.

Out of 24 samples analyzed for TCLP metals, 21 contained one or more metals exceeding TBC values. Metals exceeding TBC values included barium, cadmium, chromium, lead, mercury and silver. TCLP hazardous waste characteristic values were exceeded for lead (5 ppm) at 6MW3S (2-4') 52 ppm, at 6TB5 (2-6') 32 ppm, and at 6SS3 (0-0.5') 6.2 ppm. Lead values were generally elevated around Building 491 (former battery acid handling), indicating battery acid releases occurred in this area. Many inorganic constituents exceeded established background levels based on mass weight analysis. These included antimony, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, zinc and boron. The majority of these elevated metals are likely related to a combination of past landfill disposal and scrap metal storage.

No petroleum hydrocarbons were detected in the ground water samples. Trichloroethene and 1,2 dichloroethene were present in three downgradient wells (6MW2S, 6MW3S, and 6MW4S). Trichloroethene exceeded the ARAR value (5 ppb) with a concentration of 8 ppb at well 6MW4S. The primary source of the solvents in the ground water, based on the soil analytical results and the soil gas data, is projected to be in the area of 6TB4, 6MW4S, 6TB6 and 6TB7.

No SVOs, PAHs, pesticides or PCBs were detected in any wells at the DRMO site. Low levels of phthalates and benzoic acid were detected in the upgradient well 6MW5D. The inorganic ground water analysis results indicate that selenium exceeds the primary drinking water standards (ARARs) at wells 6MW2S, 6MW3S, and 6MW4S. The cause of the selenium levels in the ground water is unclear, but appears to be site related. Radiological screening values were exceeded in two of the ground water sample locations for gross beta. The elevated readings could be the result of naturally occurring radioisotopes which do not meet the regulatory screening criteria, but further analysis is required for confirmation.

No VOCs, SVOs, pesticides, or PCBs were detected in the upgradient surface water sample. Comparison of the inorganic results for this sample with the downgradient water sample (Goss Cove) did not suggest any detectable impact on the Thames River from NSB-NLON based on this limited data set.

Human Health Risk Assessment: Several identified exposure pathways were evaluated for Area A. They are listed as follows:

- Citizens attending auctions and public sales at DRMO;
- Navy workers sorting scrap metal;
- Workers repairing/installing utilities;
- Construction of a Hazardous Waste Storage Facility; and
- Exposure to fugitive dust from DRMO.

Negligible or *de minimus* risks were calculated for Citizens attending auctions and public sales, Utility workers repairing/installing utilities, and Exposure to fugitive dust from DRMO. The following exposure scenarios did exhibit risks which fall within the one in ten thousand and one in one million excess cancer risk range:

- Navy workers sorting scrap metal (risk due to PCBs, PAHs, and beryllium in surface soils); and

- Construction of a Hazardous Waste Storage Facility (risk due to elevated level of PCBs at northern portion of site).

Although ground water quality exceeds drinking water standards, no drinking water wells are within the affected area, nor could they be due to the proximity of the brackish Thames River.

Ecological Risk Assessment: Ground water from this site discharges to the Thames River. Based on the available data, contaminant concentrations in ground water are predicted to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the Thames River estuary. Risks to fish due to contaminants in ground water discharge from these sites are expected to be low.

8.2.2.2 Recommendations

It is recommended that this site proceed to the Feasibility Study phase. In the interim, specific health and safety provisions are recommended for all future subgrade construction projects at the site. Prior to construction in specific site areas, further subsurface investigation may be required to characterize the quality, health and safety, and potential disposal requirements of the material. The geophysical survey indicated the presence of buried metal objects at three locations as defined in Section 4.0. Any future construction planned near these areas should include exploratory excavation to identify health and safety construction requirements.

Due to the potential risks to site workers resulting from contaminated surface soils, it is recommended that worker health and safety procedures be developed to mitigate this risk. The risks are primarily related to incidental oral and dermal exposure. It is suggested that coveralls and gloves be worn during these activities and that hands be cleaned following working.

The following additional data requirements are recommended to be developed during the Feasibility Study phase.

1. Further environmental risk assessment of the potential impact of the site on the Thames River should be conducted, to verify that the impacts are negligible. This would include surface water samples at low tide (ground water discharge conditions), sediment sampling, and biota survey/sampling along the Thames River shoreline.

2. Conduct another ground water sampling and analysis round for TCL organic and TAL inorganic parameters to confirm the analytical results. Perform specific radiological isotope ground water analyses to determine the source of the radiological constituents (natural or otherwise).

8.2.3 Lower Subase

8.2.3.1 Summary

Background: The Lower Subase is located along the western edge of NSB-NLON, adjacent to the Thames River. It is bounded by the Thames River to the west and by the Penn Central Railroad to the east. The Lower Subase is the original subase and, therefore, its history dates back to 1867. Most of the construction took place in the early 1900s with major expansion between 1935 to 1945. Extensive portions of this area have been filled. The Lower Subase has always been used for operations and maintenance functions. Those functions typically generate industrial and hazardous wastes such as petroleum oils and cleaning solvents. Also located at the Lower Subase are two sets of concrete underground storage tanks located at the northern end of the study area. Four USTs are located just north of the powerhouse, and seven USTs are located just south of Building 107. In addition, there is an extensive underground fuel oil and diesel oil distribution system at the Lower Subase.

Previous investigations (NESO, 1979 and Wehran, 1987) have identified subsurface oil contamination associated with both sets of underground storage tanks, a waste oil pit in Building 79, in which historically, diesel train engines were serviced, and the underground fuel oil distribution system.

The Navy has implemented a substantial program to replace these underground tanks and the fuel oil distribution system. Of the ten concrete underground storage tanks, six now serve as spill contaminant for new steel tanks, three have been properly abandoned, and one is out-of-service. The Navy, while retrofitting or abandoning these tanks, did not detect any major structural defects or cracks. The underground #6 oil lines will be abandoned in the future based upon present Navy plans. All of the subsurface #2 oil lines, which are direct buried, were replaced or installed in 1980.

Nature and Extent of Contamination: To determine the extent and degree of contamination at the Lower Subase, investigations included the installation of 17 new wells and five soil borings. Soils from the five soil borings were only field screened for contamination. Soil samples were collected from all monitoring well installations. Ground water from all 17 wells and seven existing wells were sampled. All soil and ground water samples were analyzed for TCL volatile organics, TAL inorganics, total petroleum hydrocarbons, and fluorescence "fingerprint" analysis. In addition, soils were also analyzed for TCLP metals.

The following findings and conclusions are provided.

- Ground water at the Lower Subase is relatively clean with only slight exceedances of ARAR values at four locations. VOC standards were exceeded at 13MW2 and 13MW13, and metal standards were exceeded at 13MW9 and NESO10. These ARARs are based on standards for drinking water.

- No free product was detected in the subsurface, other than very thin layers in 13MW5 and MH83. No oil releases were observed along the bulkhead at the Thames River.

- A large area of subsurface soil near of Building 29 contains petroleum hydrocarbons which apparently originate from both sets of underground storage tanks. Although petroleum contamination is evident, no ARAR/TBC values for soils are exceeded.

- Ground water near Building #29 had a pH ranging from 9-11. This high pH is indicative of an ongoing release, and is apparently due to the discharge of boiler blowdown to the subsurface.

- A smaller area of subsurface soil adjacent to Building 79 contains petroleum oils and low levels of organic solvent. TBC values for organics are only slightly exceeded at one sample location 13MW13. The apparent source of this contamination is the former onsite oil pit in Building 79.

- Low levels of petroleum products are ubiquitous in the Lower Subase soils and ground water. The apparent source of this contamination is the accumulation over the years of minor spills and leaks.

- Elevated lead levels in soils were detected in several locations scattered across the site. Of these, two locations had TCLP lead levels high enough to classify the soils as a hazardous waste (13MW11 and 13MW15). The lead contamination may have resulted from former lead-acid battery management operations that used to be performed at the Lower Subase. Lead was not detected in ground water above ARARs.

- The subsurface free product detected in previous studies is no longer present. It is concluded that some of this oil has migrated to the Thames River, and the remainder has been adsorbed to soils.

- Low levels of thallium were detected in ground water at wells 13MW15 and 13MW16.

Human Health Risk Assessment: Several identified exposure pathways were evaluated for the Lower Subase. They are listed as follows:

- Utility workers exposed to soils and ground water in utility vaults;

- Utility workers exposed to soils and ground water during utility excavation work;

- Future construction of buildings in Lower Subase; and

Negligible or *de minimus* risks were calculated for these exposure scenarios.

Although ground water quality exceeds drinking water standards in a few wells, no drinking water wells exist in the affected area, nor could they due to the proximity of the site to the brackish Thames River.

Ecological Risk Assessment: Ground water from the Lower Subase discharges to the Thames River. Based on available data, contaminant concentrations in ground water are projected to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the much greater flow (compared to ground water flow) in the Thames River estuary. Risks to aquatic life due to contaminants in ground water discharge from these sites are expected to be low.

8.2.3.2 Recommendations

It is recommended that this site proceed to the Feasibility Study phase.

The following additional data requirements are recommended to be developed during the Feasibility Study.

- Further subsurface soil sampling with testing for total and TCLP lead should be performed in areas of elevated lead levels in soils to define the extent of soil that is classified as a hazardous waste.

- Conduct another ground water sampling and analysis round for TCL and TAL parameters detected to confirm analytical results and TCL SVOs to confirm the assumptions made in the risk assessment. The risk assessment estimated SVO concentrations based upon total petroleum hydrocarbon concentrations.

- A health and environmental risk assessment of the potential impact of the site on the Thames River should be conducted, to verify the qualitative assessment that impacts are negligible. This would include surface water samples at low tide (ground water discharge conditions), sediment sampling, and potentially biota survey/ sampling along the Thames River shoreline.

- A testing program should be developed for the buried #2 fuel oil lines (installed in 1980) to insure that they are not leaking and do not leak in the future.

- The abandonment of the #6 oil lines should be done in a manner to prevent any future subsurface release of #6 oil.

- The one tank (H) that is out-of-service should be properly abandoned.

- The apparent release of boiler blowdown to the subsurface at Building #29 should be investigated and corrected.